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Improving burn care and preventing burns by establishing a burn database in Ukraine

Gennadiy Fuzaylov [a,*], *Sushila Murthy* [b], *Alexander Dunaev* [c], *Vasyl Savchyn* [c], *Justin Knittel* [b], *Olga Zabolotina* [d], *Maggie L. Dylewski* [e], *Daniel N. Driscoll* [f]

[a] *Harvard Medical School, Department Anesthesia, Critical Care and Pain Medicine, Massachusetts General Hospital, 55 Fruit Street, Gray/Jackson 409, Boston, MA 012114, United States*
[b] *Resident in Anesthesia, Department of Anesthesia, Critical Care and Pain Medicine, Massachusetts General Hospital, 55 Fruit Street, Boston, MA 012114, United States*
[c] *Municipal Hospital #8, Lviv, Ukraine*
[d] *Doctors Collaborating to Help to Children, Corporation, Wayland, MA 01778, United States*
[e] *Shriners Hospital for Children, Boston, MA 02114, United States*
[f] *Harvard Medical School, Massachusetts General Hospital, Boston, MA 012114, United States*

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ABSTRACT

Background: Burns are a challenge for trauma care and a contribution to the surgical burden. The former Soviet republic of Ukraine has a foundation for burn care; however data concerning burns in Ukraine has historically been scant. The objective of this paper was to compare a new burn database to identify problems and implement improvements in burn care and prevention in this country.
Methods: Retrospective analyses of demographic and clinical data of burn patients including Tukey's post hoc test, analysis of variance, and chi square analyses, and Fisher's exact test were used. Data were compared to the American Burn Association (ABA) burn repository.
Results: This study included 1752 thermally injured patients treated in 20 hospitals including Specialized Burn Unit in Municipal Hospital #8 Lviv, Lviv province in Ukraine. Scald burns were the primary etiology of burns injuries (70%) and burns were more common among children less than five years of age (34%). Length of stay, mechanical ventilation use, infection rates, and morbidity increased with greater burn size. Mortality was significantly related to burn size, inhalation injury, age, and length of stay. Wound infections were associated with burn size and older age. Compared to ABA data, Ukrainian patients had double the length of stay and a higher rate of wound infections (16% vs. 2.4%).
Conclusion: We created one of the first burn databases from a region of the former Soviet Union in an effort to bring attention to burn injury and improve burn care.

* *Corresponding author*. Tel.: +1 617 643 3416; fax: +1 617 726 9697.
E-mail addresses: gfuzaylov@partners.org, gfuzaylov@yahoo.com (G. Fuzaylov).
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1. Introduction

Burns are described as the 'forgotten public health crises' by the World Health Organization (WHO) and are the second leading cause of death worldwide among people between the ages of 5 and 29 years [1]. Moreover, burns contribute to the global surgical burden, an area that is being increasingly recognized as a substantial public health concern [2–4]. Burns are predominantly a problem among populations with economic insecurity, as over 95% of fatal fire-related burns occur in low- and middle-income countries [5–7]. Since 1991, Ukraine is a newly sovereign country in Eastern Europe composed of 24 provinces with a population of 46 million people. Ukraine has a long history for burn care and an infrastructure inherited from the former Soviet Union with 33 burn centers in major cities, many dedicated physicians, nurses and other medical practitioners. However, with the collapse of the Soviet Union, burn programs in particular have become decentralized and resources for maintaining and updating facilities and training caregivers have dwindled [8–11].

Epidemiological studies are vitally important because they provide objective information upon which to base burn prevention efforts toward reduction in incidence of burn and improvement in hospital burn care. Treatment efforts can also be improved to better serve the injuries that predominate in different locales. These efforts must be assessed for effectiveness. The creation and growth of burn registries in high-income countries has contributed to the steady improvement in burn morbidity and mortality [12–14]. Unfortunately, data concerning burns in Ukraine has historically been scant. Recognizing this need, we sought to vigorously collect and analyze data regarding burns in one province in Ukraine. Our objective was to compare this new Ukrainian database from Lviv Province with data from already existing ABA data aiming in to identify strategies for improvement in Ukrainian burn care. In gathering the information we used the parameters of the ABA database as a template in hopes that this comparison may highlight the difference in resource high vs. resource poor care. In defining these differences, low cost opportunities for improvement can be found.

2. Methods

This retrospective study consists of data of all patients with burns who were admitted to 20 hospitals, including Burn unit in Municipal Hospital #8, Lviv in Ukraine from 2010 to 2011. Data were collected from hospital medical records by burn surgeons in Lviv. Following the outline of the ABA repository, the burn database included the following demographics: region, date of injury, gender, age, and etiology of burn. Patients were stratified into three groups based on TBSA: patients with $\leq$10% TBSA, 11–29% TBSA, and $\geq$30% TBSA. Clinical data included: size of the burn injury (total percentage and degree), location of burn injury, presence of inhalation injury, coexisting disease, outcome, length of hospital stay, in hospital complications (pneumonia, wound infection, septicemia, urinary tract infection, or renal failure), mechanical ventilation, length of time to first surgical excision after the injury, and blood transfusion. Data was compared to the 2012 American Burn Association National Burn Repository (ABA NBR), which included 163,771 patients in the United States admitted to designate burn centers [14].

All data was analyzed using Microsoft Excel (Microsoft Corp., Redmond, WA) and SAS® Version 9.1 (SAS institute, Cary, NC). Patients were stratified into groups according to burn size. Analysis of variance, Tukey's post hoc test, chi square analyses, and Fisher's exact test were used to assess differences among groups. Multivariate logistic regression was used to determine predictors of mortality and wound infection. This work was approved by the Partners Human Research Committee (Protocol Number: 2012P000913) and by the Chief of the Burn Services in this province in Ukraine.

3. Results

The study database included 1752 thermally injured patients. Gender, age, and time from admission to excision remained roughly equal among TBSA groups. Nearly 61% of the burn patients were men. Most burns (88%) were less than 10% TBSA and 62.6% were less than 5% TBSA. Children under the age of 5 accounted for 34% of the cases, while adults aged 60 years or older represented 13.4% of the cases. Scald burns were the primary etiology (70%) of injury among all patients. However, among patients with burns >30% TBSA, flame was the predominant etiology (41 patients, two thirds of this group).

Outcome measures, including length of stay (LOS), mechanical ventilation use, infection rates, and death increased with greater TBSA (Table 1). For patients with less than 10% TBSA, the average LOS was 18 ± 16 days. The average LOS increased to 37 ± 31 days among patients with $\geq$30% TBSA. The average length of time until the first surgical excision was 13 days after the burn injury. Wound infection was the most frequent clinically related complication and occurred in 16% of all patients. The second most frequent complication was urinary tract infection, occurring in 3.4% of patients. Ninety-five percent of UTIs were noted in patients older than 17 years of age and 51% of UTIs were in patents with less than 10% TBSA. Thus the higher incidence of UTI s was not associated with larger burns. Pneumonia was less frequent and occurred in 0.3% of all patents. These five patients all had an inhalation injury. The frequency of pneumonia did not appear to be related to mechanical ventilation, as less than 0.1% of patients (two patients) were mechanically ventilated. Mechanical ventilation is not routinely available in burn centers in Ukraine. The incidence of sepsis was present only in patients aged 20 years and older. One quarter of all patients who received blood transfusions had a burn area of less than 10%. Importantly, there are neither strict transfusion policies nor frequent use of hemostatic techniques in Ukraine. In-hospital mortality rate in our sample was 1.5% and all were older than 22 years of age (Table 1).

There was seasonal variation in the occurrence of scald burns in the sample population, among both adults and children, with most scald burns occurring in the winter months of January and February (Fig. 1). When stratifying the

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Table 1 – Patient demographic characteristics and outcome measures.

	Total (n = 1752)	≤10% TBSA (n = 1534)	11–29% TBSA (n = 156)	≥30% TBSA (n = 62)	p value
Gender					
Male	1074 (61%)	937 (61%)	97 (62%)	40 (65%)	0.7643
Female	678 (39%)	597 (39%)	59 (38%)	22 (35%)	
Type of burn					
Flame	354 (20%)	240 (16%)	73 (47%)	41 (66%)	<0.0001
Scald	1225 (70%)	1127 (73%)	80 (51%)	18 (29%)	
Contact	62 (4%)	61 (4%)	1 (0.7%)	0 (0%)	
Electrical	25 (1%)	24 (2%)	0 (0%)	1 (2%)	
Other	80 (5%)	76 (5%)	2 (1.3%)	2 (3%)	
Age at admission (years)	28 ± 25	27 ± 25	34 ± 26	38 ± 23	<0.0001
Inhalation injury	61 (3%)	28 (27%)	17 (1%)	16 (1%)	<0.0001
TBSA, burn (%)	6.4 ± 8.7	3.9 ± 2.7	17 ± 4.6	42 ± 14	<0.0001
TBSA, third-degree burn (%)	3.0 ± 5.8	1.6 ± 1.8	7.8 ± 5.3	23 ± 16	<0.0001
Admission to excision (days)	13 ± 14	11 ± 14	17 ± 4.6	10 ± 12	0.3258
Length of stay (days)	18 ± 16	16 ± 13	32 ± 20	37 ± 31	<0.0001
Operations needed	0.3 ± 0.7	0.2 ± 0.6	1.1 ± 1.8	1.1 ± 1.8	0.8674
Mechanical ventilated patients					
Total	7 (<1%)	1 (<1%)	1 (<1%)	5 (8%)	<0.0447
Ventilated >1day	1 (<1%)	0 (0%)	0 (0%)	1 (2%)	0.7645
Received blood transfusion	81 (5%)	25 (2%)	29 (19%)	27 (44%)	<0.0001
Wound infection	283 (16%)	188 (12%)	63 (40%)	32 (52%)	<0.0001
Pneumonia	6 (0.3%)	2 (0.1%)	1 (0.6%)	3 (4.8%)	0.007
Urinary tract infection	60 (3.4%)	32 (2%)	15 (10%	13 (21%)	<0.0001
Sepsis	11 (0.6%)	2 (0.1%)	4 (2.6%)	5 (8%)	<0.0001
Mortality	27(1.5%)	4(0.1%)	8 (5%)	15 (24%)	<0.0001

Data are n (%) or mean ± SD.

etiology of burn injury by age group, scald burns accounted for almost 94% of all burns in children from 0 to 4.9 years and were responsible for the majority of burns in the remaining age groups (Fig. 2).

3.1. *Comparisons to ABA National Burn Repository*

The data from this Ukrainian burn database was compared with the 2012 ABA National Burn Repository of 163,771 patients in the United States (Table 2) [24]. The gender of burn patients was similar between both databases. Ukrainian patients tended to be younger, with 29% of patients between the ages of 1 and 4.9 years vs. 14% patients of patients in the ABA data. Ukrainian patients tended to have smaller TBSA; 82% of Ukraine patients had TBSA <10% compared with 72% of ABA database. A greater percentage of Ukrainian patients had scald burns compared to patients in the ABA database. Despite being younger and with smaller TBSA, the length of stay among Ukrainian patients was approximately 9 days longer than the patients in the ABA database. The wound infection rate was also significantly greater in the Ukrainian database, 16% compared to 2.4% in the ABA database. Interestingly, there was a reduced rate of pneumonia, sepsis, and mortality in Ukrainian patients compared to the ABA data (Table 2).

Fig. 1 – Seasonal variation for scald burns among adults and children.

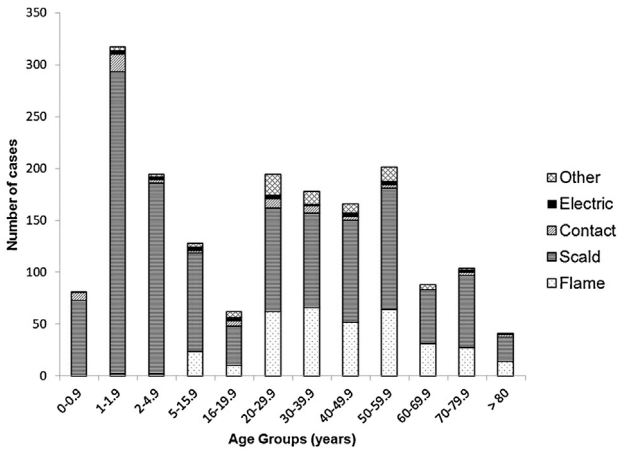

Fig. 2 – Etiology of burn injury per age group.

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Table 2 – Ukrainian data compared to ABA National Burn Repository.

	Ukrainian data	ABA
<10% TBSA	1437 (82%)	103,914 (72%)
% Male	1074 (61%)	125,147 (69%)
Age category (years)		
0–0.9	87 (5%)	9,406 (5%)
1–1.9	315 (18%)	14,096 (8%)
2–4.9	193 (11%)	11,671 (6%)
5–15.9	123 (7%)	17,070 (9%)
16–19.9	70 (4%)	9690 (5%)
≥20	964 (55%)	118,504 (67%)
Etiology		
Flame	350 (20%)	67,216 (44%)
Scald	1226 (70%)	50,674 (33%)
Contact	70 (4%)	13,556 (9%)
Electrical	18 (1%)	5999 (4%)
Other	88 (5%)	16,201 (10%)
Length of stay (days)	18 ± 16	8.9 ± 0.1
Wound infection rate	16%	2.4%
Pneumonia rate	0.3%	4.8%
Mechanical ventilated patients	<1%	14%
Urinary tract infection rate	3.4%	3.4%
Sepsis rate	0.6%	2.4%
Mortality rate	1.4%	3.7%

Data are *n* (%) or mean ± SD.

3.2. *Predictors of morbidity and mortality*

TBSA, inhalation injury, age, and length of stay were associated with increased mortality using multiple logistic regression. Inhalational injury was a strong predictor of mortality with an odds ratio that was 32 times greater than that for patients without inhalational injury (Table 3). In addition, increasing TBSA was significantly associated with increased mortality. Older age was also a predictor of mortality with and odds ratio of 1.08. Counter-intuitively, a longer length of stay was significantly associated with lower risk of mortality (Table 3). Possible explanations for this that the deaths in severely burned patients occur in the first two weeks of the resuscitation due to lack of respiratory therapy, ventilators and adequate ICU support in Ukraine.

Patients with larger burn size, longer length of stay, and older age each had significantly increased odds of wound infection (Table 4). Similarly, larger burn size, longer length of stay, and older age were each associated with increased odds of pneumonia and increased odds of urinary tract infection. Only larger burn size and older age were associated with increased risk of sepsis; length of stay had no significant association with sepsis (Table 4).

Table 3 – Multiple Logistic Regression to assess predictors of mortality.

	Point estimate of odds ratio for mortality (95% Wald confidence limits)	*P* value
TBSA	1.10 (1.05–1.16)	<0.0001
Inhalation injury	32.8 (5.56–193)	0.0001
Age	1.07(1.03–1.12)	0.0008
Length of stay	0.90 (0.84–0.97)	0.0033
Pneumonia	0.064 (0.00–2.55)	0.1439
Wound infection	1.34 (0.22–8.17)	0.7511
Sepsis	639 (38.9 to >999)	<0.001

4. Discussion

In this paper we discuss a new database of patients with burns from Lviv province in Ukraine in an effort to identify strategies and areas for improvement in burn management. Most patients in our database, both pediatric and adult, suffered from scald injury; though in the TBSA >30% group, and flame injury was the most common etiology. We also noted seasonal variation in scald burns with most occurring in the winter months. The vast majority of patients admitted to hospitals within the selected province in Ukraine with a burn injury survive, although the chance of mortality is increased with larger TBSA or the presence of an inhalational injury. One quarter of all patients in our database who received blood transfusions had TBSA burn <10%. Compared to ABA data, burn patients in this province of Ukraine tended to be younger, more likely to have scald burns, have a longer length of stay, and have a higher wound infection rate.

Based on these data, multiple areas of improvement for burn care in Ukraine may be highlighted. First, based on this data there exists a dire need for strategies to prevent scald burns in Ukraine. Effective burn care utilises a comprehensive prevention program among the general population [15–17]. The United States began improving burn care with the institution of prevention programs in 1970 [6,18]. Unfortunately, similar practices have yet to be implemented in many low and middle income countries. Significant interventions on the part of the Ukrainian government as well as extensive education initiatives may be needed to accomplish this goal.

Second, the increased wound infection rate among Ukrainian burn patients in our database highlights another potential target for improvement. Ukrainian patients in our database had nearly 8 times the number of wound infections as patients in the ABA database. The Health System encourages longer lengths of stay to keep beds occupied. That is the reason why patients with relatively small burn

Table 4 – Multiple Logistic Regression to assess predictors of infection.

	Point estimate of odds ratio for infection (95% Wald confidence limits)							
	Wound infection	*P* value	Pneumonia	*P* value	Urinary tract infection	*P* value	Sepsis	*P* value
TBSA	1.038 (1.023–1.053)	<0.0001	1.07 (1.03–1.11)	0.006	1.04 (1.02–1.06)	<0.0001	1.07 (1.05–1.10)	<0.0001
Length of stay	1.054 (1.044–1.064)	<0.0001	1.03 (1.01–1.05)	0.014	1.03 (1.02–1.04)	<0.0001	1.02 (1.00–1.04)	0.05
Age	1.033 (1.027–1.039)	<0.0001	1.10 (1.03–1.16)	0.003	1.03 (1.02–1.04)	<0.0001	1.04 (1.01–1.07)	0.016

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injury stay in the hospital for three weeks. Although these patients are relatively low maintenance but this practice increase rate of wound infection. Also early excision and grafting is rarely performed per Soviet era bias. Performing early excision and grafting require strong infrastructure to support Burn Unit: ICU, Blood Bank and anesthesiology service specifically trained for burns. Reducing infections will likely involve substantial efforts for education among medical staff as well as a full assessment of infection prevention in burn patients in Ukraine.

One area of concern involving in-hospital care of burns in Ukraine is the trend of blood transfusion. We found that a quarter of all patients who received a blood transfusion had a burn area of <10%. One of the explanation for the high blood transfusion rate in Ukrainian patients is less frequently use of hemostatic techniques during surgical procedures (local infiltration with epinephrine solution, using epinephrine soaked sponges, tourniquet use, etc.). Another explanation of liberal transfusion is relatively a low cost and availability of blood. Lack of adequate knowledge and training in anesthesia and intensive care of burn patients contributed in dogmatic beliefs of blood transfusion in burn.

Transfusion practices remain non-uniform worldwide, with no universal transfusion triggers in practice. Nevertheless, given that a large number of transfusions occurred in patients with low TBSA, the triggers for these transfusions are unclear. Unfortunately blood transfusion data were not addressed in the ABA NPR for comparison with our database. Future studies need to address this issue in more detail; specifically transfusion triggers in burn patients and possible standardization of transfusion protocols. Interestingly, we noted that the mortality rate among our database patients was significantly lower than that seen in the ABA database, as were the rates of pneumonia and sepsis. We believe that the low hospital mortality rate for burn patients in Lviv province compared to the ABA data should not lead to complacency. As described by Dr. Robert Sheridan, the natural history of severe burns is characterized by several stages: (1) pre-hospital care and transport, (2) burn shock in the first few post-injury days, (3) burn wound sepsis in the first few post-injury weeks, and (4) post-burn deformity and reconstruction [6]. We believe our data belies the greater difficulty in Ukraine of transporting severely burned patients with large TBSA to the hospital and that many severely burned patients do not survive to reach the burn unit; patient mortality in the field was not included in our data. The lower rates of sepsis and pneumonia as well as the low rates of mechanical ventilation are consistent with the theory that severely burned do not survive long enough due to lack of ICU and perioperative support to develop burn wound sepsis. Also mechanical ventilation, respiratory therapy and experience providers are not readily available and can account for the deceptively low rate of pneumonia [6].

Our data is one of the few representations of burn data from a country of the former Soviet bloc after the dissolution of the USSR. Prior to this study, such information was often classified and there is minimal published data in either English or Russian regarding burn care in Ukraine. Our study describes a country with a unique economic profile with the relatively recent adoption of a free-market model and recent loss of funding from the USSR. Ukraine's resources are fewer than those of Western European countries, however, there exist opportunities to better allocate existing resources to improve burn care. Our study adds to established burn research in many countries of high, middle, and low income in varied parts of the world [13,14,19–27]. Additional strengths of our study include its large sample size, encompassing nearly 2000 patients who suffered from burns in Lviv province in Ukraine over two years.

A limitation to this study includes that the Ukraine database and the ABA National Burn Registry were designed differently. Our database included all patients who were admitted to hospitals in one Ukrainian province with burns over a two-year period. Health care practitioners in Ukraine are currently doing outstanding work to care for burn patients despite limited resources and training, but the healthcare system in Ukraine being a socialized system is organized differently than the system in the US. Many patients with smaller TBSA are routinely admitted as burn patients and many burn patients are hospitalized in non-specialized centers. Our sample was mostly composed of patients with small burns, with 82% of Ukrainian patients hospitalized with burns having a TBSA of less than 10%. In contrast, patients in the ABA database comprised of a convenience sample of patients admitted to specialized burn units and may not capture less significant injuries treated outside of these specialized units. As such, we would expect to find patients in our sample to have less severe injury than patients in the ABA database, and this likely contributed to the lower mortality and complication rate seen in our database. Additional limitations of this study are that it was conducted retrospectively and that it concentrated only on data from patients admitted to hospitals.

The best burn centers in high income countries can save burn patients with burns over 90% of the body's surface area [7]. Unfortunately, similar practices have yet to be implemented in low and middle income countries where burns of over 40% TBSA are often fatal because of the limitation of care [19–21]. Epidemiological studies such as this one are the first step needed to initiate changes in care, as they can identify specific prevention targets and differences in care through comparison with databases from higher income countries. These studies are relatively simple to perform and can be applied to many other regions of the world. In Ukraine, this study has helped identify some of the basic deficiencies in their approach to burn care. Future studies should further address systematic preventative measures to reduce the overall incidence as well as addressing in-hospital care such as wound infection prevention, organized resuscitation and monitoring of blood product administration.

5. Conclusion

Burns are a serious public health problem worldwide and should undergo further study, particularly in low-resource settings. We established one of the first burn databases from a region of the former Soviet Union and compared our data with that from the ABA NPR in an effort to bring attention to the issue of burn injury and burn care in a developing country.

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This baseline can now be used to assess the effectiveness of strategies, such as prevention, to improve care and outcomes.

Conflict of interest statement

None.

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